A PRELIMINARY ACCOUNT OF THE PROTURA OF AUSTRALIA.

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(*Communicated by Dr. R. J. Tillyard.*)

(Twenty Text-figures.)

[Read 27th April, 1932.]

Dr. R. J. Tillyard (Insects of Australia and New Zealand, 1926) stated that this order had not so far been found in either Australia or New Zealand. Prof. W. J. Dakin, in a letter to *Nature* (19th June, 1926), said of the pabulum in which specimens of Peripatus were sent to England: "A few termites were present in the soil and there were a number of Protura". Inquiries in Australia have elicited the information that the soil was collected by Miss M. G. C. Fordham in the Nannup district. As Prof. Dakin's communication was the first suggestion that Protura occurred in Australia, I immediately wrote to him requesting the opportunity of examining the soil in question. Publication of his letter had been delayed for some two months, and in the meantime the material had been thrown away. This possible first record of Protura from Australia consequently cannot be substantiated by description of specimens or species.

Since my arrival in Western Australia in September, 1930, I have paid special attention to these insects and have been able to examine and study all the specimens so far taken by myself and other entomologists, and the result is embodied in this paper.

In all, six species have been determined, four belonging to the genus *Acerentulus* Berlese, and two to *Eosentomon* Berlese. From Western Australia are now known the two species of *Eosentomon* and three of *Acerentulus*, the fourth species of the latter genus having beeen found in Federal Territory by Dr. R. J. Tillyard, and in Victoria by Mr. F. H. Drummond. The bulk of both species and actual specimens from Western Australia were found by Mr. D. C. Swan of the Biological Department of the University of Western Australia.

His first specimen was taken from leaves lying at the foot of Eucalypts in the University grounds at Crawley, W.A., 30/10/30. Other specimens were taken later in the same locality and also, by Mr. Swan and myself, from similar habitat in King's Park, Perth. I have since (28/8/31) taken *Eosentomon westraliensis*, n. sp., at Greenbushes, 159 miles south of Perth, while still more recently (30/9/31) Mr. Swan has found five specimens of *Acerentulus occidentalis*, n. sp., in the Darling Ranges near Pinjarra, about 50 miles south of Perth. Both the species on these occasions were found under deeply embedded stones, while the original captures were from decaying leaves, etc., and the specimens obtained by means of the Berlese funnel. Apart from these records, all specimens were from Crawley and King's Park. More intensive collecting in other parts of Australia will doubtless bring to light more species and a very wide distribution.

To Mr. D. C. Swan of the University of Western Australia I would like to express my deep appreciation of his intensive search for these interesting insects

in which he has been so extremely successful. He has also very kindly checked up the chaetotaxy of the various species.

This order of insects was first discovered by Prof. Silvestri (1907) in Italy when he described *Acerentomon doderoi*. Prof. Berlese (1909) in a monograph on the order described many species. He differed, however, from his fellow countryman in regarding them as closely related to the myriapods and not to the insects. In his work he calls them *Myrientomata*.

Whether they should be regarded as myriapods rather than insects depends on the importance to be attached to the feature of "anamorphosis" possessed by these creatures. This anamorphosis consists of the interpolation of additional abdominal segments one at a time, between the last and last but one, as the creature grows from the nine- to the twelve-segmented stage. This is, of itself, a myriapod character and does not occur in any other insects except in a secondary manner in the antennae and cerci of some Apterygota. The absence of antennae in all known species, with one possible exception, has also been used to support the argument against their being insects. On the other hand, the mouth parts, distinct division of body into head, thorax and abdomen, and position of the genital opening show without much doubt that they are really insects, and most authorities to-day agree with Prof. Silvestri in regarding them as such. They may perhaps be considered as an early branch of the primitive insect stock running parallel with the myriapod stem. It would consequently be earlier than any of the known forms of the true insects (including the Collembola).

The Protura differ from all other insects in possessing in the adult twelve abdominal segments, the last three of which in life are telescoped within the others. With the possible exception of *Protapteron indicum* (Schtf., 1909) which I have discussed elsewhere, all known species lack antennae. The head is usually egg-shaped and the mouth-parts are contained within the head capsule. In one genus the labrum is produced in a snout-like manner. Eyes are entirely absent, but on each side of the head is a small oval or circular sensory organ termed a pseudocellus.

The thoracic segments are well developed, generally strongly chitinized and carry the usual three pairs of legs. The insects are remarkable in that, in life, the front legs, which are comparatively long and possess special sensory hairs on the tarsi, are not used for walking but rather as tactile organs in place of the antennae. Each tarsus carries a single claw with a bristle-like empodium. The claws are generally evenly curved on all feet, but in the family Eosentomidae those on the front feet are S-shaped. In the family just mentioned the meso- and metathoracic segments have a pair of stigmata. These are not known in any other family, with the possible exception of the Protapteridae.

The abdomen is generally tapering and well chitinized, especially towards the apex. Towards the front edge of each tergite is a more strongly chitinized band known as an apodeme. Although these apodemes vary a little in curvature in the different genera, they cannot be used for specific differentiation as has been done by some workers. In this respect I have previously shown (1927) that they also vary very greatly during the immature stages. The first three abdominal segments also carry a pair of appendages. In the Eosentomidae all three pairs are two-jointed, while in the Acerentomidae the first or first and second pairs only are two-jointed. In some genera, on the posterior lateral corners of the tergites, there is a small pectine or comb which varies somewhat between species.

Of the life history of these minute creatures little is known. The largest species known does not exceed 2 mm. in length.

They occur in more or less damp situations, under stones well buried in clayey marl, in moss, in peat, and under bark. Although they can be picked out under a lens in the field when they occur under bark or under stones they can best be got from moss, etc., by bringing it home and putting it through the Berlese funnel.

The earliest known instar is that with nine segments. The eggs have not been seen except *in situ* in the ovaries. Here they are comparatively large, occupying about one-third of the abdomen.

Distribution.

Including the new species described in this paper there are now 49 species of Protura known. From the different regions of the world they are as follows: Europe, 26; America, 15; India, 2; South Africa, 1; Java, 1; Australia, 6. The number of American species probably needs revision for, as I have previously indicated, the character used, namely, the forking or otherwise of the apodemes, is not a good character on which to separate species. This character varies within the larval stages.

Classification.

I. Antennae present, many jointed. Thoracic stigmata present on front of segments 2 and 3 ..... Fam. Protapteridae Börner.—*Protapteron indicum* Schptf.

II. No antennae. Stigmata, when present, on sides of segments.

1. Stigmata absent. First or first and second pairs of abdominal appendages two-jointed. Pectines usually present on segments v and viii ..... Fam. Acerentomidae Berlese.

a. First pair only of abdominal appendages two-jointed ..... Subfam. Acerentominae Womersley.

aa. Labrum produced, snout-like ..... Gen. *Acerentomon* Silv.

bb. Labrum not produced ..... Gen. *Acerentulus* Berlese.

b. First two pairs of abdominal appendages two-jointed ..... Subfam. Merentominae Womersley.

cc. Abdominal tergal apodemes absent, all segments dorsally with a single row of setae. Pectines absent ..... Gen. *Merentomon* Womersley (= *Protentomon* Ewing, preoccupied).

dd. Abdominal tergal apodemes present. Tergites i-vi and viii with an anterior row of two setae. Segment viii with modified pectines ..... Gen. *Parentomon* Womersley.

2. Meso- and metathorax with lateral stigmata. All three pairs of abdominal appendages two-jointed ..... Fam. Eosentomidae Berlese.—Gen. *Eosentomon* Berlese.

Description of Australian Species of Protura.

Acerentulus Berlese.

Acerentulus westraliensis, n. sp. Text-figs. 9, 10.

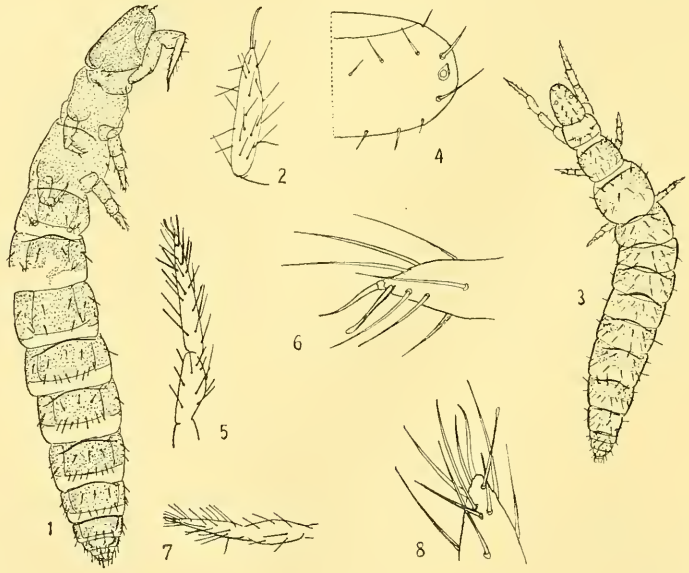
Length (extended with acetic acid), 875 μ. Head 75 μ long, 65 μ wide, almost round; pseudocelli 8 μ diam.; head well chitinized; front cephalic setae 12 μ long, basal setae 12 μ. Thorax well chitinized, with slight apodemes on meso- and metathorax. Front legs 210 μ long, tarsus 54·6 μ, claw evenly curved, 15·4 μ, ratio of length of tarsus to claw =TR = 3·5, subapical setae 22 μ long. Middle legs 98 μ, tarsus 22·4 μ, claw 11·2 μ. Hind legs 106 μ, tarsus 25·4 μ, claw 14 μ. Abdominal segments strongly chitinized, especially apically, apodemes present on segments i-viii, simple and curved on i-vii, nearly straight on viii. Pectines present on tergite viii, but indistinct. Abdominal appendages on segments i-iii normal, i 20 μ long, ii and iii 14 μ. Chaetotaxy as in figures and table of species.

This appears to be one of the most abundant forms so far found in Australia. It has been taken by Mr. Swan as follows: University Grounds, Crawley, W.A., 2/11/30 (2 specimens), 21/4/31 (1 specimen), 8/5/31 (1), 11/6/31 (1), 9/7/31 (1).

ACERENTULUS AUSTRALIENSIS, n. sp. Text-figs. 3, 11, 12.

Length (extended), 750 μ. Head 84 μ × 61·6 μ, moderately chitinized, pseudocelli round, 8 μ diam., front cephalic setae 12 μ, basal setae 5 μ. Thoracic segments well chitinized, apodemes on ii and iii. Front legs 176 μ, tarsus 21·6 μ, claw evenly curved, 11·75 μ, TR= 4·75, subapical setae 16·8 μ. Middle legs 92 μ, tarsus 21·6 μ, claw 8·4 μ. Hind legs 100·8 μ, tarsus 28 μ, claw 10 μ. Abdomen well chitinized, tapering posteriorly, apodemes present and strongly chitinized on tergites i-viii, curved on i-vii, straight on viii. Pectines present but indistinct on segment viii. First pair of abdominal appendages 28 μ long, second and third pairs 14 μ. Chaetotaxy as in figures and table of species.

This form, which is very distinct in the chaetotaxy of the eighth sternite, as well as the value of the tarsal claw ratio (TR), has so far been found on only one occasion. It was found by Mr. Swan in leaf mould in the University Grounds, Crawley, W.A., on 30/10/30.



Text-figs. 1-8.

1, 2.—*Acerentulus tillyardi*, n. sp. 1. Drawing of Dr. Tillyard's specimen, ventral view. 2. Front tarsus and claw.

3.—*Acerentulus australiensis*, n. sp. Dorsal view.

4-6.—*Eosentomon westraliensis*, n. sp. 4. Right half of mesothorax showing stigma. 5. Terminal joints of front leg. 6. Tip of tarsus of front leg showing claw.

7-8.—*Eosentomon swani*, n. sp. 7. Terminal joints of front leg. 8. Tip of front tarsus and claw.

ACERENTULUS TILLYARDI, n. sp. Text-figs. 1, 2, 13, 14.

Length (unextended) 750 μ, (extended) 875 μ. Head 89·6 μ × 61·6 μ, well chitinized, pseudocelli small, 5·6 μ diam., front cephalic setae 14 μ, basal setae 8·5 μ. Thoracic segments only moderately chitinized, apodemes barely visible on meso- and metathorax. Front legs 193 μ, tarsus 59 μ, claw evenly curved, 19·6 μ, TR= 3·0, setae 20 μ. Middle legs 101 μ, tarsus 33·6 μ, claw 8·4 μ. Hind legs 112 μ, tarsus 37·8 μ, claw 9·8 μ. Abdomen more chitinized, tapering posteriorly, apodemes curved on segments i-vii, nearly straight on viii, slightly forked anteriorly on vii, pectines on segments v and viii scarcely visible. Chaetotaxy as in figures and table of species.

This is the only species so far found in the eastern States. It was first found by Dr. R. J. Tillyard in soil from the base of a tree-fern at Blundells', F.C.T., 18/2/31. On this occasion only one specimen was obtained. Several other specimens of the same species were found by Mr. F. H. Drummond, of Melbourne University, at Belgrave, Victoria, on 19/4/31.

This species is very similar to *A. westraliensis* in the arrangement of setae, but differs distinctly in the value of TR.

ACERENTULUS OCCIDENTALIS, n. sp. Text-figs. 15, 16.

Length (extended) 1350 μ. Head 124 μ × 81·5 μ, well chitinized, pseudocelli 9·8 μ diam., front cephalic setae 20 μ, basal setae 10 μ. Thorax well chitinized, segments ii and iii with distinct apodemes. Front legs 270 μ, tarsus 88 μ, claw 22 μ, TR= 4·0, setae 32 μ. Middle legs 160 μ, tarsus 39 μ, claw 15 μ. Hind legs 176 μ, tarsus 42 μ, claw 16·3 μ. Abdomen tapering, strongly chitinized, apodemes on i-vii thin, strongly curved and simple, on viii practically straight, distinct pectines on viii with teeth of equal length. First abdominal appendages 33 μ long, second and third 22 μ. Chaetotaxy as in figures and table of species.

This species is the largest so far known from Australia, and was taken by Mr. Swan as follows: University Grounds, Crawley, W.A., 21/4/31, 29/6/31; Fairbridge Farm, Pinjarra, W.A., 30/9/31 (5 specimens under stones).

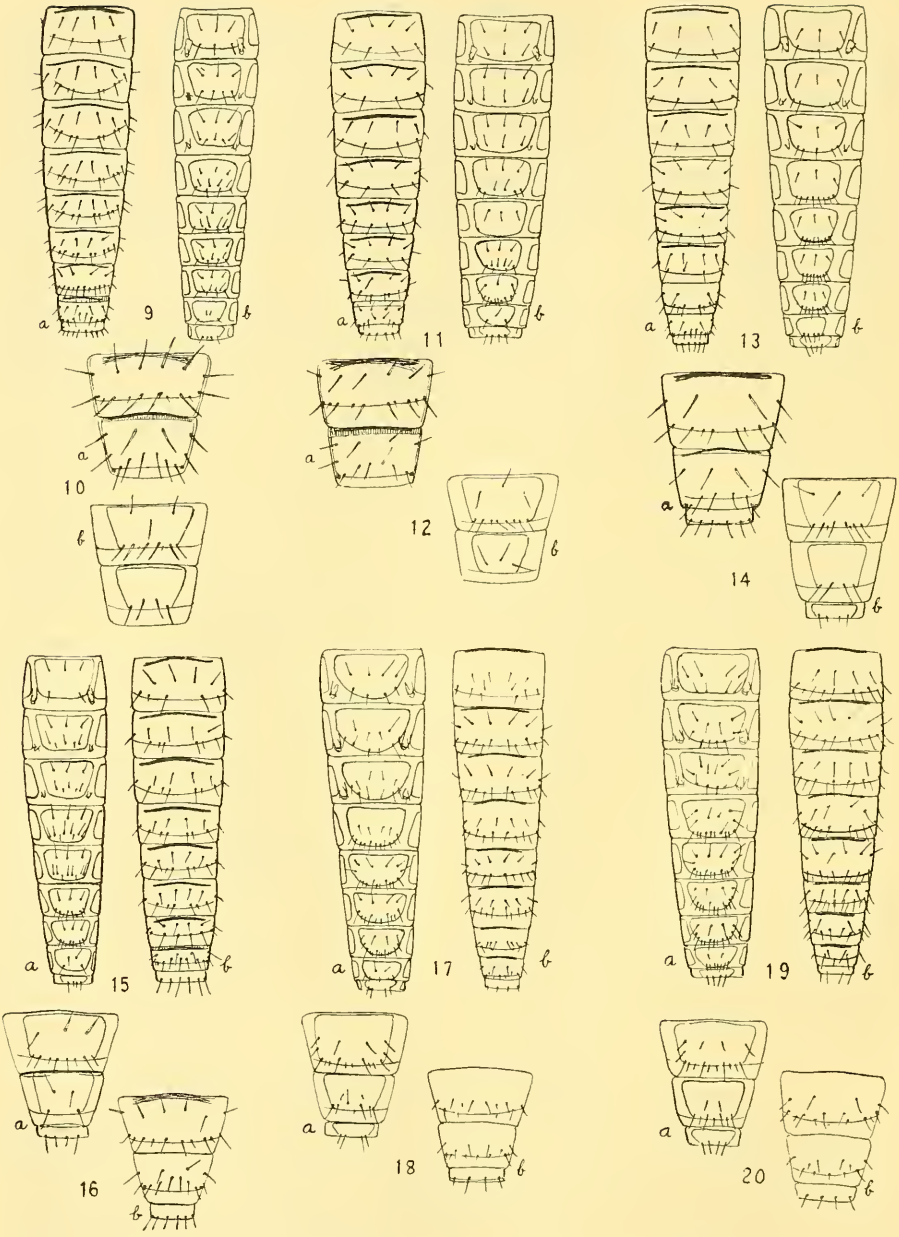
Table for Australian species of the genus Acerentulus.

1. Sternite viii with only three macrosetae in a single subposterior row. TR = 4·75. Length 750 μ ..... *australiensis*, n. sp.
   Sternite viii with four macrosetae 2
2. Macrosetae on sternite viii in two rows, an anterior submedial pair and a posterior sublateral pair. TR = 4·0. Length 1,350 μ ..... *occidentalis*, n. sp.
   Macrosetae on sternite viii in a single subposterior row 3
3. TR = 3·5. Length 875 μ ..... *westraliensis*, n. sp.
   TR = 3·0. Length 875 μ ..... *tillyardi*, n. sp.

Genus EOSENTOMON Berlese.

EOSENTOMON WESTRALIENSIS, n. sp. Text-figs. 4–6, 17, 18.

Length (extended) 1,250 μ. Head well chitinized 124 μ × 91 μ, labrum not produced, pseudocelli large, long, diam. 15 μ; front cephalic setae 10 μ, basal setae 10 μ. Thorax much chitinized, slight apodemes on segments ii and iii, spiracles laterally on segments ii and iii, diameter 6 μ. Front legs 326 μ, tarsus 98 μ, claw S-shaped, 16·3 μ, TR = 6·0, setae 30 μ. Empodium bristle-like almost reaching tip of claw, apical clavate hair present. Middle legs 179 μ, tarsus 49 μ, claw evenly curved, 13 μ. Hind legs 212 μ, tarsus 49 μ, claw evenly curved, 15 μ. Abdomen well chitinized, tapering posteriorly, apodemes thin and almost straight on i-viii, pectines absent. All three pairs of abdominal appendages 39 μ × 19 μ. Chaetotaxy as in figures.



Text-figs. 9-20.—Diagrammatic figures showing arrangement of setae.

9-10.—*Acerentulus westraliensis*, n. sp. 9*a*. Tergites i-ix. 9*b*. Sternites i-ix. 10*a*. Tergites vii and viii enlarged. 10*b*. Sternites vii and viii enlarged.

11-12.—*Acerentulus australiensis*, n. sp. 11*a*. Tergites i-ix. 11*b*. Sternites i-ix. 12*a*. Tergites vii and viii enlarged. 12*b*. Sternites vii and viii enlarged.

13-14.—*Acerentulus tillyardi*, n. sp. 13*a*. Tergites i-ix. 13*b*. Sternites i-ix.

King's Park, Perth, W.A., 19/4/31, 21/4/31 (H.W.); Crawley, W.A., 19/5/31, 7/7/31 (D. C. Swan); Greenbushes, W.A., 28/8/31 (H.W.), (3 specimens under deeply embedded stones in clay soil).

EOSENTOMON SWANI, n. sp. Text-figs. 7, 8, 19, 20.

Length (extended) 1,175 μ. Head 98 $\mu \times 85$ μ, almost round, labrum not produced, pseudocelli 9–10 μ, front cephalic setae 10 μ, basal setae 6·5 μ. Thoracic segments well chitinized, ii and iii with slight apodemes and spiracles, the latter 8 μ diam. Front legs 260 μ, tarsus 78 μ, claw sinuate 17·3 μ, TR = 4·5, setae 30 μ, apical clavate hair present, empodium almost reaching tip of claw. Middle legs 140 μ, tarsus 28 μ, claw 9 μ. Hind legs 173 μ, tarsus 42 μ, claw 12 μ. Abdomen well chitinized with thin almost straight apodemes on tergites i-viii. All three pairs of abdominal appendages 39 $\mu \times 19$ μ. Chaetotaxy as in figures.

Crawley, W.A., 2/11/30, 18/5/31, 19/5/31, 6/6/31, 11/6/31, 14/6/31, 29/6/31, 27/7/31 (D. C. Swan).

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14*a*. Tergites vii-ix enlarged. 14*b*. Sternites vii-ix enlarged.

15-16.—*Acerentulus occidentalis*, n. sp. 15*a*. Sternites i-ix. 15*b*. Tergites i-ix. 16*a*. Sternites vii-ix enlarged. 16*b*. Tergites vii-ix enlarged.

17-18.—*Eosentomon westraliensis*, n. sp. 17*a*. Sternites i-ix. 17*b*. Tergites i-ix. 18*a*. Sternites vii-ix enlarged. 18*b*. Tergites vii-ix enlarged.

19-20.—*Eosentomon swani*, n. sp. 19*a*. Sternites i-ix. 19*b*. Tergites i-ix. 20*a*. Sternites vii-ix enlarged. 20*b*. Tergites vii-ix enlarged.

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